

CA1 EP 59076E06

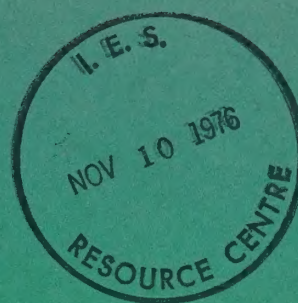
Canada. EPS. WPCD.

EPS 3-WP-76-6

A MODIFICATION OF THE TRADITIONAL SEQUENCES FOR THE
TREATMENT OF WASTEWATERS FROM METAL FINISHING
INSTALLATIONS. 1976.

ment

la
de
ment



CA 1 EP59076E06



3 1761 05686717 9

A Modification of the Traditional Sequence for the Treatment of Wastewaters from Metal Finishing Installations

Earth Sciences Library

Economic and Technical Review
Report EPS 3-WP-76-6

Water Pollution Control Directorate
July, 1976

ENVIRONMENTAL PROTECTION SERVICE REPORT SERIES

Economic and Technical Review Reports relate to state-of-the-art reviews, library surveys, industrial inventories, and their associated recommendations where no experimental work is involved. These reports will either be undertaken by an outside agency or by the staff of the Environmental Protection Service.

Other categories in the EPS series include such groups as: Regulations, Codes and Protocols; Policy and Planning; Technology Development; Surveillance; Briefs and Submissions to Public Inquiries; Training Manuals; and, Environmental Impact and Assessment.

Inquiries pertaining to Environmental Protection Service Reports should be directed to the Environmental Protection Service, Department of the Environment, Ottawa K1A 0H3, Ontario, Canada

SERIE DE RAPPORTS DU SERVICE DE LA PROTECTION DE L'ENVIRONNEMENT

Les rapports sur l'analyse économique et technique concernant des revues de l'état des connaissances, des études documentaires, des inventaires industriels et des recommandations connexes dans des domaines non touchés par le travail expérimental. L'établissement de ces rapports est la responsabilité d'un organisme extérieur ou du personnel du Service de la protection de l'environnement.

Le Service compte d'autres séries de rapports: règlements, codes et méthodes d'analyse; politiques et planification; développement technologique; surveillance; exposés et mémoires découlant d'enquêtes publiques; guides de formation; évaluation et effets environnementaux.

Prière d'envoyer toute demande de renseignements ayant trait aux rapports du Service à l'adresse suivante: Service de la protection de l'environnement, Ministère de L'Environnement, Ottawa K1A 0H3, Ontario, Canada.

**A MODIFICATION OF THE TRADITIONAL
SEQUENCE FOR THE TREATMENT OF WASTEWATERS
FROM METAL FINISHING INSTALLATIONS**

by

**L. Buffa
Inorganic Chemicals Program
Water Pollution Control Directorate
Environmental Protection Service
Environment Canada**

Report No. EPS 3-WP-76-6

July, 1976

Minister of Supply and Services
Cat. No. En43-3/76-6

ABSTRACT

This analysis was initiated as an attempt, by the author, to define the effect a controlled amount of dilution water would have on the amount of contaminants discharged from metal finishing operations and their concentrations.

A simplified "traditional" chemical treatment system has been used as a model to arrive at a relationship between quantity and concentration of a given contaminant, and the ratio volume of treated process water to volume of dilution water. This relationship has been used to discuss a modified treatment system applicable to wastewater from metal finishing installations.

RÉSUMÉ

L'auteur a tenté, au moyen de la présente analyse, de déterminer l'influence d'une dilution contrôlée sur le volume et les concentrations des contaminants rejetés au cours des opérations de finissage des métaux.

Un système classique de traitement chimique simplifié a servi de modèle pour l'établissement d'une relation entre la quantité et la concentration d'un contaminant donné et entre le volume des effluents traités et celui de l'eau de dilution. Cette relation a servi à analyser un système de traitement modifié applicable aux effluents des usines de finissage des métaux.

TABLE OF CONTENTS

	PAGE
ABSTRACT	i
1 BACKGROUND	1
2 DISCUSSION	2
3 MODIFIED TREATMENT SYSTEM	6
4 CONCLUSIONS	8
APPENDIX	9



Digitized by the Internet Archive
in 2025 with funding from
University of Toronto

<https://archive.org/details/31761056867179>

1 BACKGROUND

The objective of the new federal government requirements for the metal finishing industry will be the control of contaminants, mainly heavy metals and cyanides, directly or indirectly discharged to water bodies.

Ideally the control thrust should reduce both the absolute amount of contaminants discharged and their concentrations in the final effluents.

Historically, for the metal finishing industry, various countries have imposed limitations based on concentrations of the various contaminants and the actual numerical values were justified by the need for protecting municipal sewers, aquatic life, or potable water sources. Numerical values found in foreign legislations range from a realistic assessment of what is practically achievable under normal circumstances to very strict limits achievable only with great effort and expenditure.

The result has been, to use the words of some of the electroplaters, that "dilution becomes a necessity to maintain consistency with low concentration requirements".

This analysis was initiated as an attempt, by the author, to define the effect a controlled amount of dilution water would have on the amount of contaminants discharged and their concentrations.

2 DISCUSSION

A "traditional" chemical treatment system for metal finishing wastewaters, Figure 1, is used as a model for discussion purposes. Several simplifications have been made in order to arrive at a relationship between quantity and concentration of a given contaminant, and the ratio volume of treated process water to volume of dilution water. With the notations used in Figure 1, the following relationship can be written:

$$Q_{iF} = W_F \times C_{iF} \quad (1)$$

With the final concentration of any constituent a function of the total chemical content of the given waste and of the efficiency of the operation of the wastewater treatment plant, one may also write that:

$$C_{iF} = F(PE) \times \frac{1}{E} \quad (2)$$

where: $F(PE)$: function of the total chemical content and precipitation equilibria

E : efficiency of the wastewater treatment plant (from 0 to 1.0)

From equations (1) and (2) it follows that:

$$Q_{iF} = W_F \times F(PE) \times \frac{1}{E} \quad (3)$$

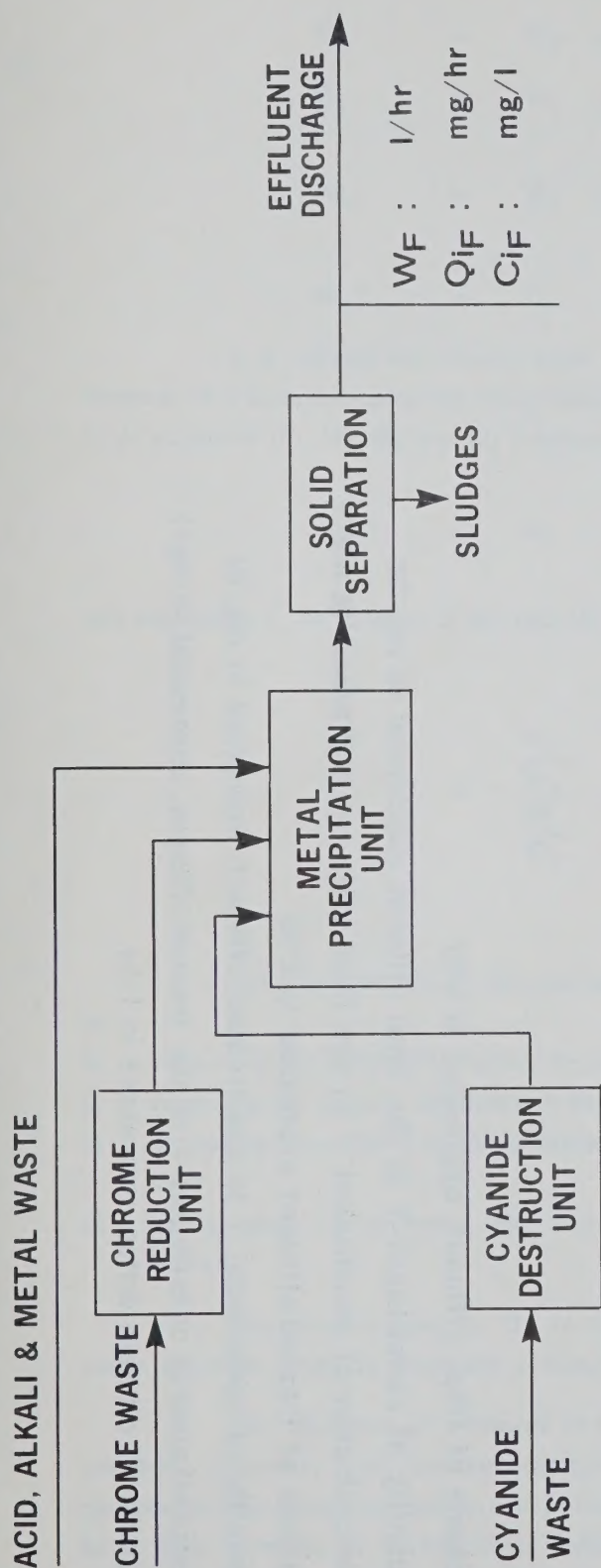
From equation (2) it can be said that the concentration of a constituent "i" discharged can be decreased by:

- a) influencing the function $F(PE)$ (selective precipitation, filtration, etc.)
- b) increasing the function E (efficiency of the wastewater treatment plant, $E \rightarrow 1.0$)

From equation (3) it can be seen that the absolute quantity Q_{iF} of constituent "i" discharged is affected in addition to $F(PE)$ and E by the amount of wastewater treated, W_F .

The relationships shown in equations (1), (2), and (3) are obvious and their meaning well known.

A step forward can now be made by assuming that some clean dilution water is added to the final effluent, after the wastewater treatment plant and before the final discharge. Such an assumption is shown in Figure 2, and, with the notations used:



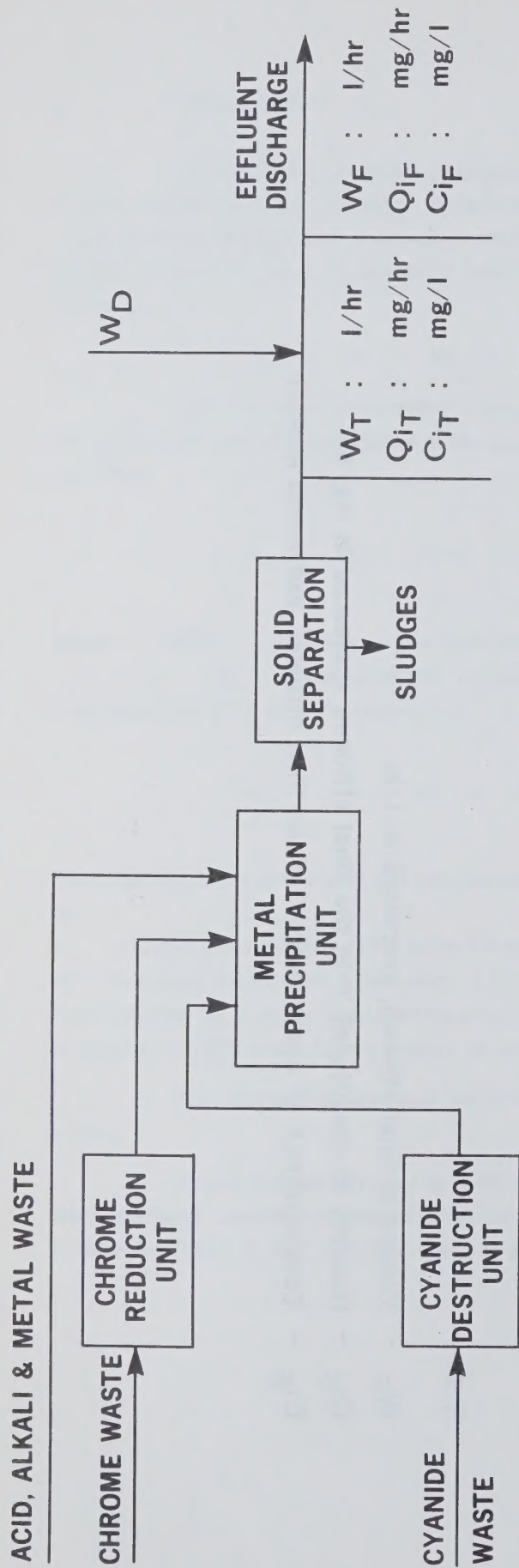
Note:

W_F - Volume of final effluent, expressed in l/hr

Q_{iF} - Quantity of constituent 'i' in the final effluent, expressed in mg/hr

C_{iF} - Concentration of constituent 'i' in the final effluent, expressed in mg/l

Figure 1 : Traditional Wastewater Treatment System



Note:

- W_F - Volume of final effluent, expressed in l/hr
- Q_{iF} - Quantity of constituent 'i' in the final effluent, expressed in mg/hr
- C_{iF} - Concentration of constituent 'i' in the final effluent, expressed in mg/l
- W_T - Volume of treated effluent expressed in l/hr
- Q_{iT} - Quantity of constituent 'i' in the treated effluent, expressed in mg/hr
- C_{iT} - Concentration of constituent 'i' in the treated effluent, expressed in mg/l
- W_D - Volume of dilution water, expressed in l/hr

Figure 2: Addition of Dilution Water to the Traditional Wastewater System

$$Q_{iF} = W_F \times C_{iF} \quad (4)$$

$$W_F = W_T + W_D \quad (5)$$

$$Q_{iT} = W_T \times C_{iT} = W_T \times \frac{F(PE)}{E} \quad (6)$$

$$Q_{iT} = Q_{iF} \quad (7)$$

It is realized that dilution water is not perfectly clean unless distilled water is used. This, however, is a secondary point for the purposes of this analysis.

From equations (4), (5), (6) and (7) it follows that:

$$Q_{iT} = Q_{iT} = W_T \times \frac{F(PE)}{E} \quad (8)$$

and expressing C_{iF} as function of the ratio W_T/W_D :

$$C_{iF} = \frac{\frac{W_T}{W_D}}{\frac{W_T}{W_D} + 1} \times \frac{F(PE)}{E} \quad (9)$$

The concentration, C_{iF} , of constituent "i" discharged with the final effluent can be decreased by:

- influencing the factor $F(PE)$ (selective precipitation, filtration, etc.);
- increasing the factor E (efficiency of the wastewater treatment plant, $E \rightarrow 1.0$)
- decreasing the volume of W_T (wastewater treated), since C_{iF} will tend to zero if W_T tends to zero;
- adding clean dilution water, W_D , after the treatment plant and prior to the discharge of the effluent.

The absolute quantity, Q_{iF} , of constituent "i" discharged is not affected by the dilution water. However, it can be decreased as noted above in (a), (b) and (c).

The allowance of a volume of dilution water would help a treatment plant operator to maintain consistency with low concentration requirements and, therefore, provide an incentive to decrease the wastewater volume as well as waste treatment plant size and costs. The final results would be a lower quantity of contaminants discharged at lower concentrations for a lower cost. The quantifications of the dilution water volume could be discussed but that is beside the point in this analysis.

3 MODIFIED TREATMENT SYSTEM

As the next step, it is assumed that the wastewater from pretreatment operations, such as alkali and acid cleaning, can be segregated, the pH adjusted and the precipitate clarified. The scheme is shown in Figure 3.

The only significant contaminant(s) present after pH adjustment and clarification would be from the cleaning of the base surface and its (their) control would be easier than the control of the mixture of contaminants originated from both the pretreatment and the treatment operations.

An additional step to clean the racks contaminated by use in previous operations may be added, if needed, before more pieces are loaded on the racks for a new cycle.

It is also assumed that, after pH adjustment and clarification, the base metal content in the wastewater from pretreatment operations is at, or close to, the level that will be allowed in the final effluent by regulatory requirements.

The relationship (9) could now be rewritten to show W_{PT} instead of W_D :

$$C_{if} = \frac{\frac{W_T}{W_{PT}}}{\frac{W_T}{W_{PT}} + 1} \times \frac{F(PE)}{E} \quad (10)$$

A variety of treatment options are open with the modified system. As an example, multiple counterflow rinsing could be used to drastically reduce the volume of wastewater treated, W_T , thus decreasing both the quantity and concentration of a contaminant discharged. The higher the ratio W_T/W_{PT} the lower the C_{if} and, with it, the need for eventual costly selective precipitation which could be necessary when the chemical content of the waste does not allow final concentration of a contaminant below the required value. Other examples could be given. In practice each existing or new plant would have to assess the benefits of the modified versus the traditional system as it would apply to the particular working conditions.

4 CONCLUSIONS

- 1) When feasible, the segregation and separate treatment of wastewaters from pretreatment operations provides the metal finisher with a means of:
 - a) reducing, with rinse water, the quantity and concentration of contaminants discharged with the final effluents;
 - b) aiding in consistent compliance with effluent requirements, expressed as concentrations of control parameters.

- 2) Segregation and separate treatment of wastewaters from pretreatment operations should be encouraged in future Canadian regulations/guidelines for the metal finishing industry. This would provide the metal finisher with a financial incentive to:
 - a) develop new technology aimed at the reduction of the volume of wastewater originating from rinses, spills, accidental spills, leaks, etc.
 - b) implement water economy (and re-use) and the recovery of metals through ion exchange, evaporation, reverse osmosis and other internal controls. The benefits of reducing the volume of wastewater treated would add to the economics of recovery and reuse.

APPENDIX

DEVELOPMENT OF RELATIONSHIPS (8) AND (9)

Appendix

DEVELOPMENT OF RELATIONSHIPS (8) AND (9)

$$Q_{iF} = Q_{iT}$$

$$Q_{iT} = W_T \times \frac{F(PE)}{E}$$

$$Q_{iF} = Q_{iT} = W_T \times \frac{F(PE)}{E} \quad (8)$$

$$Q_{iF} = W_T \times \frac{F(PE)}{E}$$

$$Q_{iT} = W_F \times C_{iF} = (W_T + W_D) \times C_{iF}$$

$$W_T \times \frac{F(PE)}{E} = (W_T + W_D) \times C_{iF}$$

$$\frac{W_T}{W_D} \times \frac{F(PE)}{E} = \frac{1}{W_D} (W_T + W_D) \times C_{iF} = \frac{W_T}{W_D} + 1 \times C_{iF}$$

$$C_{iF} = \frac{\frac{W_T}{W_D} \times \frac{F(PE)}{E}}{\frac{W_T}{W_D} + 1} \quad (9)$$

NOTE: See Figure 2 for notations.

